



**EXCOM/COs Meeting 2011**

Agenda Item: 2.4.4

Person Responsible: John Storey

**Edinburgh, 16,18,19<sup>th</sup> July 2011**

# **Report on Astronomy and Astrophysics from Antarctica**

**(AAA)**

# Executive Summary

**Title:** Report on Astronomy and Astrophysics from Antarctica (AAA)

**Authors:** John Storey (Chief Officer), with input from the Working Group Chairs

**Relevant URLs or references to other reports:** The AAA SRP web site is at:

<http://www.astronomy.scar.org/>

**Introduction/ Background:** The Astronomy and Astrophysics from Antarctica (AAA) SRP was launched in 2010 in recognition of the rapidly growing level of international activity in Antarctic astronomy, and the desirability of improved cooperation and coordination in this field.

**Important Issues or Factors:** AAA will hold its kick-off meeting in Sydney in 2011, June 28 – July 1. There have been two changes to the Steering Committee, which now has the following members:

Lyu Abe	(France) – replacing Nicolas Epchtein
Philip Anderson	(United Kingdom)
Michael Burton	(Australia)
Xiangqun Cui	(China)
Takashi Ichikawa	(Japan)
Albrecht Karle	(USA)
James Lloyd	(USA)
Silvia Masi	(Italy)
John Storey	(Australia) – Chief Officer
Hongyan Zhou	(China) – replacing Lifan Wang

**Recommendations/Actions and Justification:** None is requested at this stage.

**Expected Benefits/Outcomes:** NA

**Partners:** No formal partners, although the IAU is now a Union Member of SCAR.

**Budget Implications:** Continuing funding is requested at the approved level.

## Astronomy and Astrophysics from Antarctica SRP

### *Background*

The SCAR AAA SRP Planning Group held two meetings during 2009: in Frascati, Italy and in Rio de Janeiro, Brazil; and a further meeting in 2010 in Buenos Aires, Argentina.

### *Kick-off meeting*

SCAR AAA SRP will hold its kick-off meeting over three days at the Taronga Zoo in Sydney at the end of June 2011. A total of 55 people from 8 countries have registered. Additional funding for the meeting has been provided by the Australian Antarctic Division, Astronomy Australia limited, the Australian Astronomical Observatory, CSIRO, and the University of NSW. The website for this meeting is hosted by UNSW and is accessible at:

<http://www.astronomy.scar.org/AAA2011/>

### *Future meetings*

A proposal to the International Astronomical Union seeks to hold a Symposium on "*Astrophysics from Antarctica*" at the IAU's next General Assembly, to be held in Beijing in August 2012. The result of this bid should be known within a month.

### *Working Group reports*

The four Working Groups of AAA are:

- Working Group A: Site testing, validation and data archiving.
  - Chair: Jon Lawrence, Vice-chair: Tony Travouillon
- Working Group B: Arctic site testing.
  - Chair: Michael Andersen, Vice-chair: Eric Steinbring
- Working Group C: Science goals.
  - Chair: Michael Burton, Vice-chair: Hans Zinnecker (TBC)
- Working Group D: Major new facilities.
  - Chair: John Kovac, Vice-chair: Xuefei Gong

The reports from each of the Working Groups follow below.

### *Working Group A: Site testing, validation and data archiving*

#### **1. Overview (Report provided by Jon Lawrence, Michael Burton and Tony Travouillon)**

The site testing working group has developed an implementation plan over the last year. The main objective of this implementation plan is to develop a web-based resource to collate all existing and future

Antarctic site testing data and to allow future plans for collecting new data to be defined. It is also intended that this resource be linked to appropriate national and international databases. This plan satisfies SCAR Data Policy requirements that each Scientific Research Programme should have a data management plan. The working group has also attempted to find funds for the development of this web-based resource via a number of sources.

There have been continued developments over the last year in terms of the collection of Antarctic site testing data.

- The Dome A observatory continues to run with a suite of instruments measuring boundary layer turbulence, meteorology, and sky brightness.
- Instruments installed in January 2011 at Dome Fuji are similarly measuring surface layer and upper atmospheric parameters.
- At Dome C, measurements continue to characterise the integrated atmospheric turbulence and the submillimetre opacity.
- South Pole instruments have now been installed to measure the ultraviolet sky background conditions as a precursor experiment to the *Antarctic Cosmic Web Imager* telescope.

Two important new results to emerge from the Dome A programme are the extreme dryness of the atmosphere, opening it for THz observations [1], and the narrow depth of the surface boundary layer, such that a tower could readily be built to rise above it and so enable telescope to obtain the superb free-air seeing available above the plateau [2].

[1] Yang, H., Kulesa, C. A., Walker, C. K., Tothill, N. F. H., Yang, J., Ashley, M. C. B., Cue, X., Feng, L., Lawrence, J. S., Luong-Van, D. M., Storey, J. W. V., Wang, L., Zhou, X., and Zhu, Z., 2010, Exceptional THz transparency and stability above Dome A, *Antarctica*, PASP, 122, (2010), 490–494.

[2] C. S. Bonner, M.C.B. Ashley, X. Cui, L. Feng, X. Gong, J.S. Lawrence, D.M. Luong-Van, Z. Shang, J.W.V. Storey, L. Wang, H. Yan, J. Yang, X. Zhou and Z. Zhu, Thickness of the Atmospheric Boundary Layer Above Dome A, *Antarctica*, during 2009, PASP, 122, (2010), 1122–1131.

## 2. Australian Activities in 2010 – 2011 (Report provided by Michael Burton & Jon Lawrence)

The principal Australian astronomical activity in Antarctica involves the design, construction and operation of the autonomous PLATO laboratories on the high Antarctic plateau. Two such laboratories are currently operating, at Dome A (in conjunction with China) and Dome F (with Japan), with a third now under construction at UNSW for Ridge A (with the USA). At Dome A, the PLATO laboratory is in its third season of operation – having run for over 800 days continuously as of May 2011, a remarkable achievement. The Dome F PLATO was deployed, via overland traverse from Syowa, in January 2011 by Japanese scientists and has now clocked up over 100 days of continuous operation. These laboratories communicate with their control centre at the University of New South Wales in Sydney via the Iridium satellite network and operate a number of small astronomical instruments and site testing telescopes. At Dome A these include an acoustic radar (Snodar) that measures the depth and strength of the surface boundary layer.

Another acoustic radar is also operating at Dome F, measuring the properties of the boundary layer there.

The 60cm *HEAT* THz telescope is planned for deployment to Ridge A in collaboration with the USA (from the South Pole) in January 2012, and aims to survey the southern Galaxy in the ionised carbon and nitrogen emission lines.

The Australian astronomical community has just completed a mid-term review of its current Decadal Plan. The review gives the Antarctic astronomy program a strong endorsement. In particular, the continued support of the PLATO programme is recommended, with the highest priority new initiative being the development of THz capability on the summits of the Antarctic plateau, the only ground-based sites on the Earth where such observations could be regularly made. The review also notes the potential of the plateau for infrared astronomy but recognises the need for international collaboration to build a suitable mid-sized facility to take advantage of the opportunities for a wide range of astronomical investigations in this waveband.

### 3. Japanese Activities in 2010 – 2011 (Report provided by Takashi Ichikawa)

The programme "*Infrared and THz Astronomy in Dome Fuji*" has been accepted as one of 2010 – 2012 general programmes of the National Institute of Polar Research, Japan. During the term of this programme we will deploy small infrared and THz telescopes in preparation for the future construction of large telescopes (2m infrared and 7m THz telescopes). In the first year 2010/2011, we have constructed a small astronomical facility at Dome F in collaboration with the UNSW group, who provided PLATO-F. In January, we performed observations of Venus with a 40cm telescope (AIR-T40) and an infrared camera (TONIC2) and made seeing observations with a CCD camera and DIMM. In addition, we arranged the instruments for the site monitor and for astronomical observations over winter, including a weather mast of 16m height equipped with temperature sensors, supersonic anemometers, and barometer; a twin telescope of 10cm aperture on an equatorial mount (TwinCAM); web cameras; a whole-sky monitor camera (HRCAM); Snodar etc. The data have been successfully acquired via Iridium *OpenPort* with 128 kbps bandwidth since January 2011.

### 4. French Activities in 2010 – 2011 (Report provided by Lyu Abe and Nicolas Epchtein)

#### *Site qualification results:*

The site monitoring instruments DIMM (seeing and angle-of-arrival times) and GSM (seeing, outer scale, isoplanatic angle) at the Concordia station routinely recorded data during the austral summer and winter of 2010, and are currently operating during this 2011 winter. SONIC anemometers (6 modules fixed along the 45m height mast) were also recording data during 2010, but frost problems as well as physical damage of a few modules hampered the reliability and quality of measurements. The Fizeau laboratory installed a new instrument, PBL (*Profileur de Bord Lunaire*, i.e. Lunar limb profiler) in order to record high vertical resolution turbulence profiles of the surface layer. This instrument is also capable of measuring outer scale and isoplanatic angles in a model-independent way. This instrument is currently operating for its first winter.

Statistical analysis of previous seeing data of both SONIC and DIMM/GSM was carried out at Fizeau [1, 2]. They study the different turbulence regimes within the surface layer, as well as the duration of "good seeing" periods. SONIC data recorded at a height of 31m confirmed that the median surface layer thickness corresponds to this height.

#### *Photometry experiments (ASTEP and PAIX) status and results:*

The PAIX photometer has observed continuously since 2008, and continues its scientific programme on variable stars (RR Lyrae) and star population assessment in clusters [3].

The ASTEP programme comprises two instruments: a fixed one staring at the austral celestial pole (ASTEP-South), and the ASTEP400 telescope. ASTEP-South is still operating and provides photometric data since its first light in 2007 – 2008 from which photometric quality assessment for planetary transits detection was derived [4]. ASTEP400 started its first winterover in 2010 and is starting a new campaign in 2011. Data from 2010 were repatriated to Nice and are being analyzed by the ASTEP consortium. A few exoplanetary candidates have already been extracted and need to be confirmed. Excellent data quality confirmed that the sensitivity of an instrument at polar sites is equivalent to a 2.5~3 times larger instrument at a temperate site (ASTEP400 is actually equivalent to a ~1.2m telescope).

[1] Fossat, E. et al., 2009, Dome C site testing: surface layer, free atmosphere seeing, and isoplanatic angle statistics, *A&A*, 499, 955

[2] Fossat, E. et al., 2010, Typical duration of good seeing sequences at Concordia, *A&A*, 517, 69

[3] Chadid, M. et al, 2010, First Antarctica light curve. PAIX monitoring of the Blazhko RR Lyrae star: S Arae, *A&A* 516, 15

[4] Crouzet, N. et al, 2010, ASTEP South: an Antarctic Search for Transiting ExoPlanets around the celestial south pole, *A&A* 511, 36

## 5. European Activities in 2010 – 2011 (Report provided by Nicolas Epchtein)

The conclusions and recommendations of the European network ARENA, involving 7 EC countries (Belgium, France, Italy, Germany, Spain, Portugal, UK) and Australia, were released early in 2010. They are gathered into a decadal roadmap based on the reflection of six dedicated working groups [1]. A suite of instruments, mainly in the mid size range, is proposed, including, as the first priority, an infrared wide-field imaging survey telescope called PLT based on earlier studies for PILOT. A proposal to the Research Infrastructure of the EC involving a European/Australian consortium to undertake a Conceptual Design Study of this instrument was submitted to the EC [2]. Although it got an excellent ranking, it was eventually not funded. We are presently looking for new funding opportunities to resubmit this project. However it is clear that in the context of the present budgetary constraints, there is little chance that any European country will engage itself in the construction of a significant Antarctic project in the next couple of years.

[1] Epchtein N. (editor) et al., 2010a, A vision for European Astronomy and Astrophysics at the Antarctic Station Concordia, Dome C, Terra Nova Publication, accessible at: <http://arena.unice.fr>

[2] Epchtein N. (coordinator) et al., 2010b, A proposal to the European Commission for the Design Study of a Polar Large Telescope.

### *Working Group B: Arctic site testing*

#### **Canadian High Arctic Activities 2010 – 2011 (Report provided by Eric Steinbring)**

This effort is focused on Northern Ellesmere Island, centered on the Eureka research base at 80 degrees North latitude. The preliminary survey of nearby mountain sites was completed in 2010. This included small autonomous weather stations and sky-monitoring cameras deployed by helicopter from Eureka. The remote stations operated over three winters on three mountain tops, 1000 m or higher. The main results are that the remote coastal sites are accessible in summer and above the atmospheric thermal inversion in winter, providing good weather [1]. While the technical aspects of operating an observatory at one of these remote locations are investigated, a somewhat lower elevation manned location near Eureka is being developed: the Polar Environment Atmospheric Research Laboratory (PEARL). Here, two SOund Detection and Ranging (SODAR) units and a specialized lunar scintillometer have been deployed for two winters.

The first scintillometer data suggest a thin boundary layer for PEARL [2]. Analysis of the SODAR data is underway, and further measurements are being taken to confirm the results. A Differential Image Motion Monitor (DIMM) was deployed in campaign mode in early 2011. Under clear skies, good seeing was observed from the 6-m high PEARL roof. For the coming 2011/12 winter the project would again deploy DIMM, as well as a Multi-Aperture Scintillation Sensor (MASS/DIMM), in order to profile the atmospheric turbulence. The project is gaining momentum, with positive results moving ahead plans for a 0.5-m optical telescope. This would be primarily for the detection of extrasolar planet transits, and is being readied for PEARL now. This would be a precursor to a future 1 – 4 m optical/near-infrared facility, as proposed in the 2010 Canadian Long-Range Plan for Astronomy; see: [http://casca.ca/lrp2010/Draft.v4.4.2.web\\_sm.pdf](http://casca.ca/lrp2010/Draft.v4.4.2.web_sm.pdf)

[1] Steinbring, E., Carlberg, R., Croll, B., Fahlman, G., Hickson, P., Leckie, B., Pfrommer, T., & Schoeck, M., First Assessment of Mountains on Northwestern Ellesmere Island, Nunavut, as Potential Astronomical Observing Sites, PASP, 122, 1092 (2010)

[2] Hickson, P., Carlberg, R., Gagne, R., Pfrommer, T., Racine, R., Schoeck, M., Steinbring, E., & Travouillon, T., Boundary-Layer Seeing Measurements in the Canadian High Arctic, SPIE Conf. Series, 7733, 53 (2010)

### *Working Group C: Science goals*

#### **Implementation Plan (Report provided by Michael Burton & Hans Zinnecker)**

This Working Group has developed a draft Implementation Plan. The main objective is to define the kinds of astronomical observations that are best conducted from Antarctica, to outline some of the science

investigations such observations would facilitate, and to suggest ways by which these may be achieved.

A recent review of the astrophysical endeavours taking place at the South Pole was held in Washington DC (April 2011), in particular considering the state of the Cosmic Microwave Background Radio and the Neutrino experiments being conducted there. A report is currently being written summarising this activity and will provide a road map towards future developments at the Pole for the US NSF. This report will also help motivate the Implementation Plan of WG C.

A major review on Astronomy in Antarctica was published in the journal *Astronomy & Astrophysics Review* in 2010, written by the WG C Chair (Burton). This paper covers the current developments in astronomy in Antarctica, the site testing to quantify the environment, and the astrophysical results that have emerged from the diverse range of experiments that have been conducted in Antarctica over the past three decades.

### ***Working Group D: Major new facilities***

Nothing to report at this stage.